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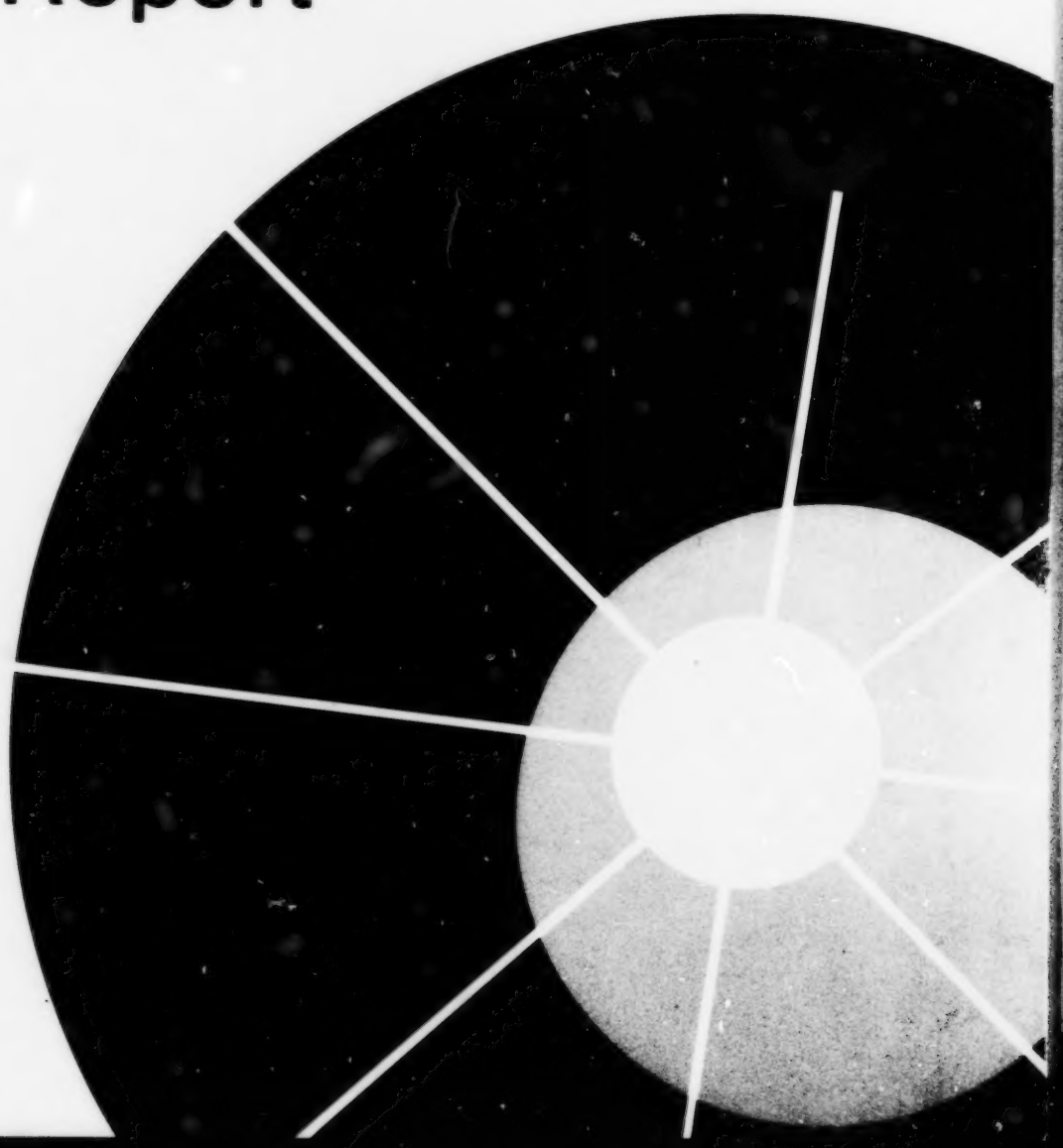
SASK 25

Canada - Saskatchewan Renewables — Conservation Demonstration Program

Final Report



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CANADA-SASKATCHEWAN CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

On March 18, 1980, the governments of Canada and Saskatchewan entered into a Conservation and Renewable Energy Demonstration Agreement. The Agreement, which terminates March 31, 1984, funds the development and demonstration of a wide range of conservation and renewable energy technologies. The program is funded on an equal cost-shared basis by Canada and Saskatchewan, and is administered by Saskatchewan.

The objectives of CREDA are:

- To develop and demonstrate promising new technologies which exploit renewable energy resources, conserve energy, or make its use more efficient;
- To create employment in new or existing industries;
- To develop broad public awareness of the potential of renewable energy and energy conservation technologies.

This report outlines the results of a project funded by the Government of Saskatchewan as represented by Saskatchewan Energy and Mines, and the Government of Canada as represented by Energy, Mines and Resources Canada, under the terms of the Renewables-Conservation Demonstration Program, and contracted with the party identified herein.

However, neither the Government of Saskatchewan as represented by Saskatchewan Energy and Mines, nor the Government of Canada as represented by Energy, Mines and Resources Canada, accept liability for any errors, omissions, or inaccuracies that may be included in or derived from this report, nor do they assume any liability with respect to the use of, or actions resulting from the use of, any information contained in this report.

Energy Audit: Luseland Recreation Centre

Retrofit of Recreation Facilities Project — Phase I

Final Technical Report
on a Renewables-Conservation Demonstration Program Project

Conducted By

Saskmont Engineering Company Limited

And Supported By

Saskatchewan Energy and Mines
and
Energy Mines and Resources Canada

Project Leader: Brian George

Miscellaneous
Report FP-11

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Executive Summary - Conclusions and Recommendations

In the spring of 1982, Saskmont Engineering Company Limited conducted an energy audit of the Recreation Centre in Luseland, Saskatchewan. The results of that audit are summarized herein.

The Recreation Centre is now designated a Heritage Building. The building remains basically unchanged since it was originally built in 1926 as a four classroom schoolhouse. Total approximate floor area is 8300 sq. ft., including two main floors, basement, and attic area. A simple one pipe gravity steam radiation system provides heat in the building. The original coal-fired boiler has been converted to burn natural gas.

The building is in very poor shape due to years of neglect. The windows are broken or missing, wind blows through the structure, the boiler is obsolete and inefficient, the control system is obsolete and causes overheating and underheating. The exterior of the building and foundation of the building appear in reasonable shape but the interior building finishes have deteriorated to the point where total renovation of the building is required.

In addition the building will not meet present fire protection standards. There are no fire separators. Fire exits are below standard and in some cases impassable or dangerous to use. There were no fire extinguishers evident in the building.

Table I summarizes minimum fix-ups that should be undertaken to improve this historic building but we would strongly recommend a complete renovation of the building.

Table I summarizes the implementation costs, energy saving, dollar saving and payback period of energy conservation measures proposed in this report. Actual total savings may be less than the sum of the individual returns since some measures diminish the return yielded by others.

All operational items are recommended (Options 1, 4, 13 and 16). Architectural options 3, 4, 6, 7 and 8 are strongly recommended. Mechanical options 2, 15 and 10 are strongly recommented. If implemented natural gas usage could be reduced by 55%. Architectural items 19, 9, 18 and 14 should be done only in conjunction with a major retrofit of the building.

Electrical item #12 should be done only if meeting room usage increases.

Table 1.0 - Summary of Energy Conservation Measures

Option	Description	Capital Cost	Annual*** Energy Saving	Percent*** of Existing	Annual Dollar Saving	Simple*** Payback (yrs)
	Operational Items					
1.	Basement temperature	Nil	540 m^3 gas	2%	$ 60	Immed.
5.	Radiator valve handles	$ 220	---	---	---	N/A
13.	Boiler pressure gauge	$ 50	---	---	---	N/A
16.	Interior window shades	$ 1,500	---	---	---	N/A
	Architectural Items					
3.	Weatherstrip front door	$ 100	1243 m^3 gas	4%	$ 130	0.8
4.	Repair and seal windows	$ 1,500	6139 m^3 gas	20%	$ 650	2.3
6.	Insulate basement windows	$ 630	2411 m^3 gas	8%	$ 250	2.5
7.	Seal roof exhaust	$ 300	957 m^3 gas	3%	$ 100	3.0
8.	Increase attic insulation	$ 1,800	2899 m^3 gas	9%	$ 310	5.8
19.	Insulate upper section of windows	$ 5,400	3085 m^3 gas	10%	$ 330	16.6*
9.	Install sealed d.g. windows	$10,400	3488 m^3 gas	11%	$ 370	24.1*
18.	Insulate basement walls	$10,000	2962 m^3 gas	9%	$ 312	32.1
14.	Retrofit wall insulation	$20,000	4621 m^3 gas	15%	$ 488	41.0
17.	Natural shading	$10,000	---	---	---	---
	Mechanical Items					
2.	Automatic flush urinals	$ 300	315,000 gallon water	---	$ 946	0.3
15.	Install automatic valves	$ 2,700	6255 m^3 gas	20%	$ 660	4.1***
10.	Insulate steam pipes	$ 940	2038 m^3 gas	7%	$ 220	4.3
11.	Replace boiler insulation	$ 1,600	1484 m^3 gas	5%	$ 160	10.0
	Electrical Items					
12.	Meeting room lighting	$ 3,680	2900 kWhr Elec.	36%	$ 162	22.7**

* Assumes option 4 is done first.
** Assumes 36 hours per month of usage.
*** If two or more items are implemented simultaneously, total savings may be less than the sum of the total due to the effect one option has on another. Strongly effects option 15. Option 15 would reduce to about 20% of that shown if other fix-ups taken.

1. INTRODUCTION

1.1 Scope of Work

In the spring of 1982, Saskmont Engineering Company Limited was commissioned by Saskatchewan Mineral Resources to conduct an energy audit of the Luseland Recreation Center.

The scope of the project included the following:

1. Collect climatic data for the North Battleford area.
2. Analyze energy consumption in the past three years with attention to growth trends and monthly cycles.
3. Study the building and mechanical and electrical infrastructure.
4. Study the operation and maintenance, and use of the building, with discussion with building personnel.
5. Identify potential energy conservation measures.
6. Identify the economics of implementing each measure.
7. Prepare a final report encompassing all the above.

Subsequent to the issue of the contract, a request was made for an infrared scan of the building. This was subcontracted to Thermal Focus Incorporated of Saskatoon.

1.2 Overview of the Complex

The Recreation Centre was originally built as a four classroom school in 1926. There have been no additions to the 8300 sq. ft. building containing two main floors, basement and attic area.

The school has been converted to a multi-purpose building several years ago.

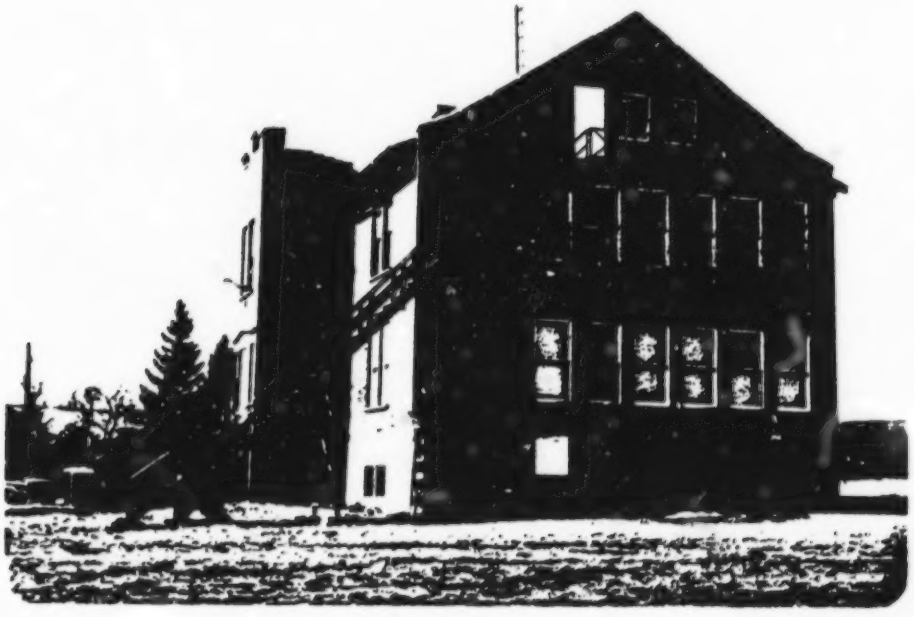
The building has fire escapes, but no fire detection/alarm system or emergency lighting.

1.3 Climatic Data

Climatic data for Luseland is not readily available. The closest centre with recorded data is North Battleford. In heat loss calculations, 10970 Fahrenheit Degree Days (65°F base) are used. Design dry bulb temperature is -30°F.

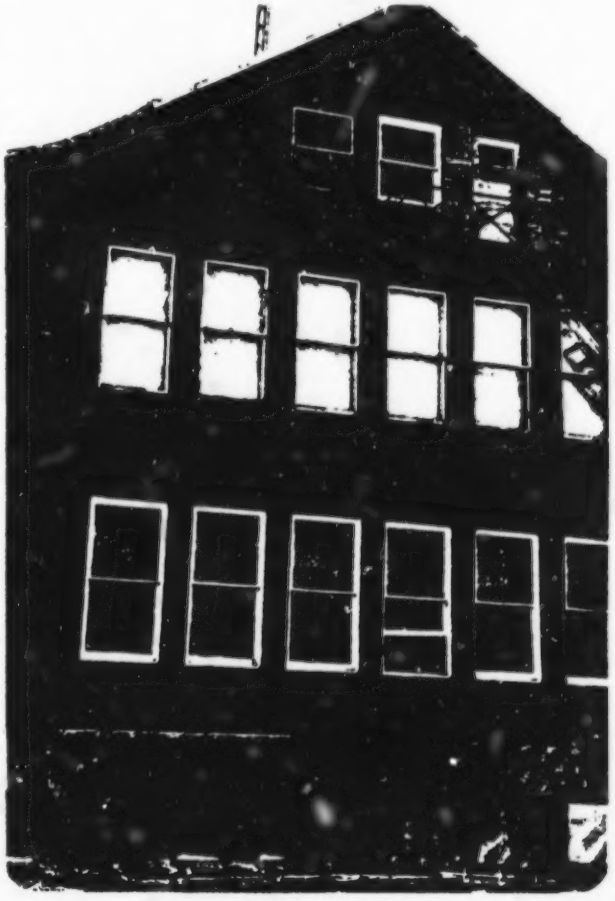
LUSELAND RECREATION CENTRE

FRONT ENTRANCE SOUTH EXPOSURE

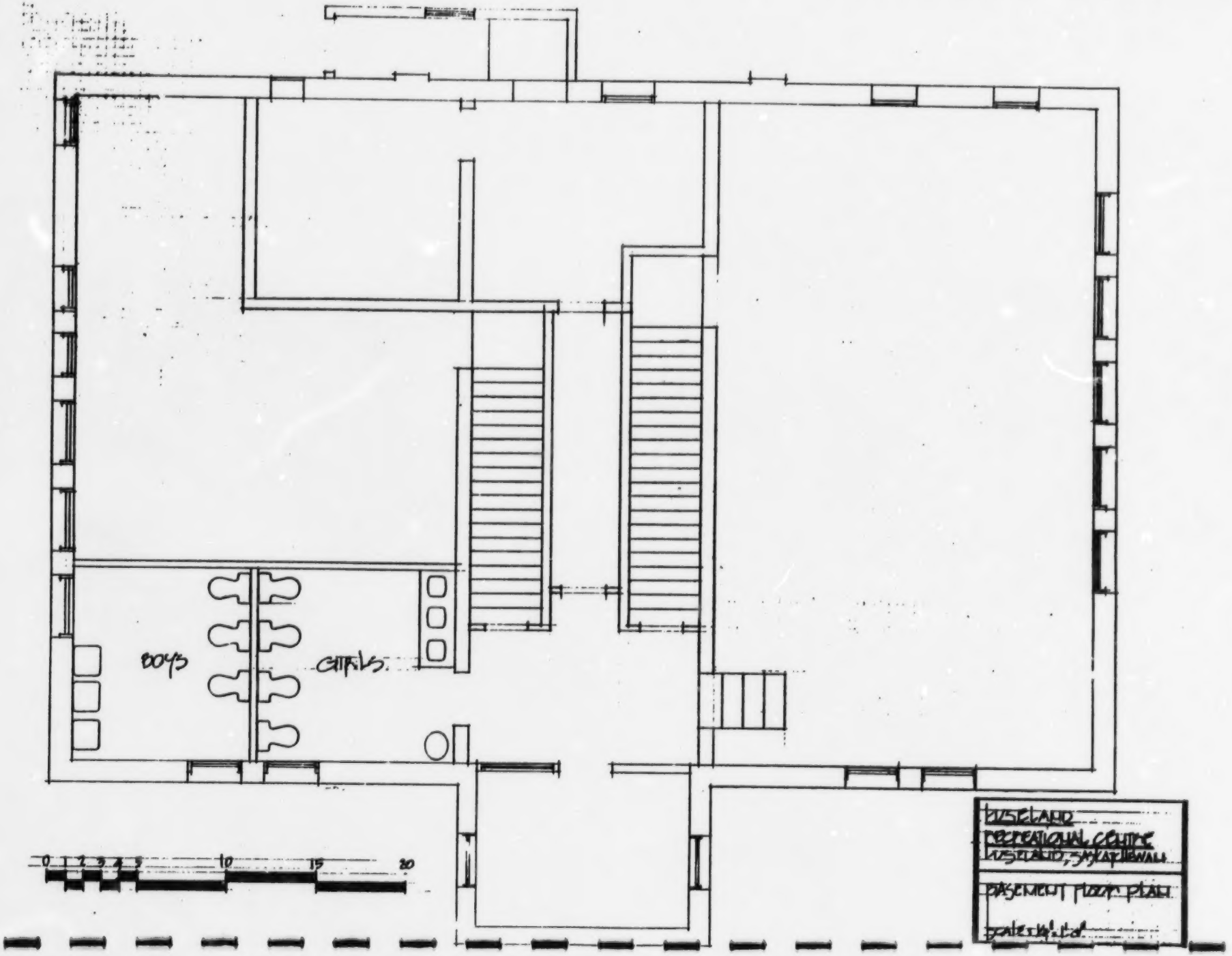


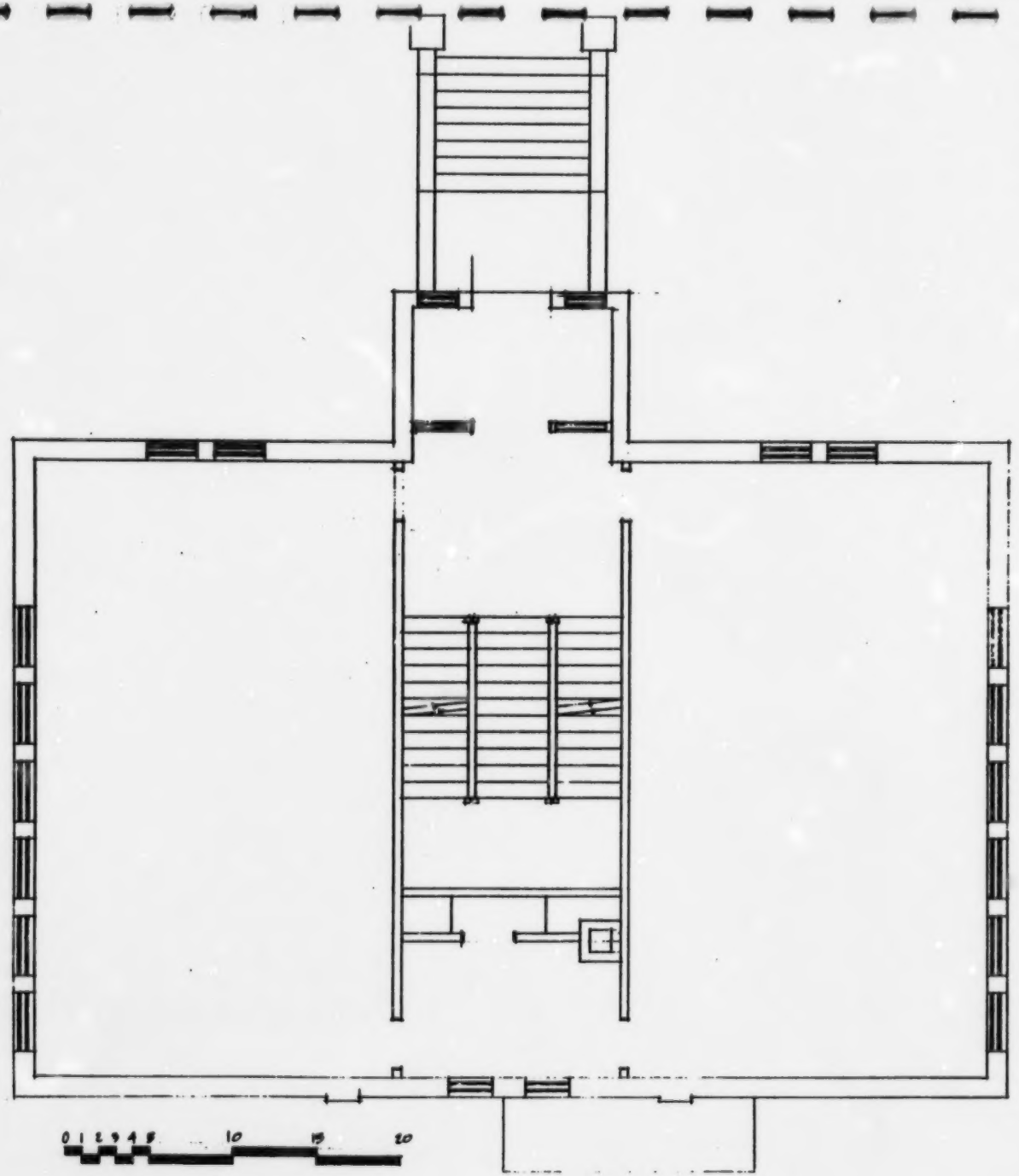
EAST EXPOSURE

NORTH EXPOSURE



WEST EXPOSURE

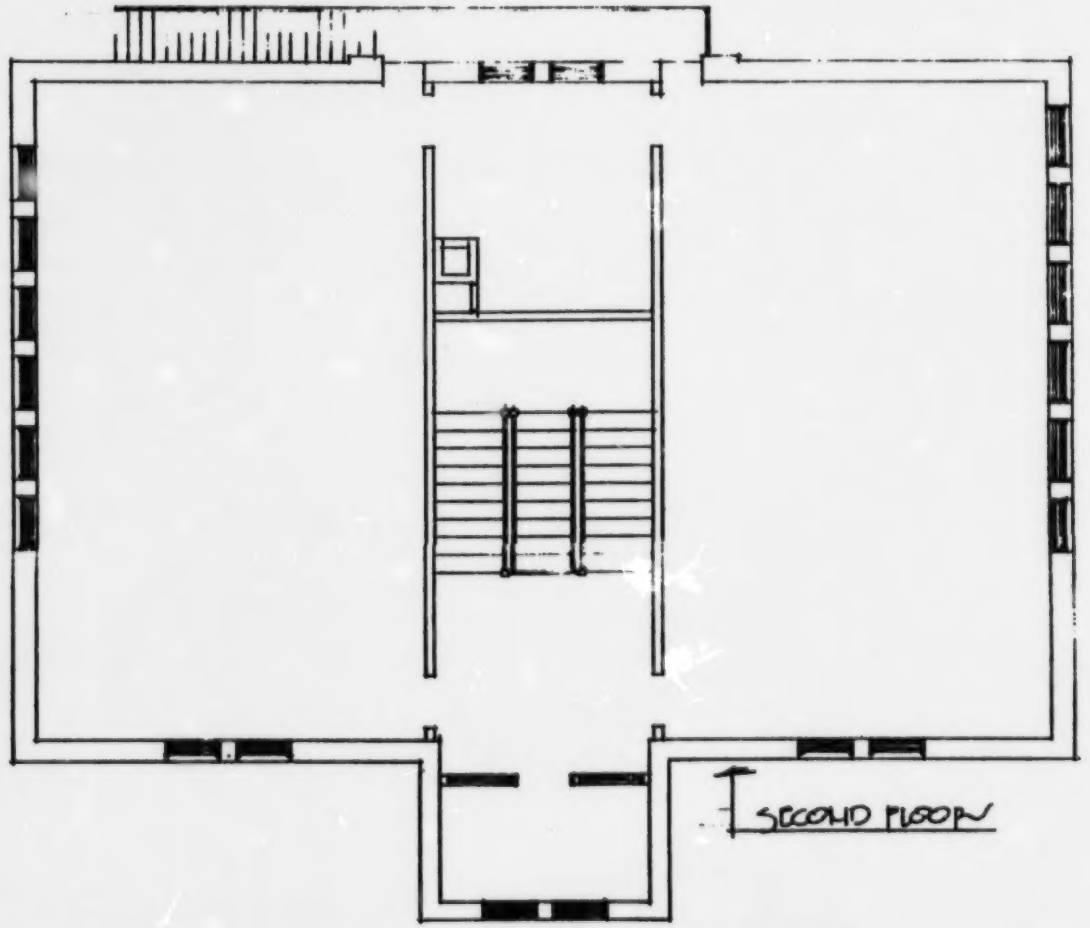

BOYS
GIRLS
0 1 2 3 4 5 10 15 20
WESTLAND
RECREATIONAL CENTRE
WESTLAND, SASKATCHEWAN
BASEMENT FLOOR PLAN
SCALE: 1/4" = 1'-0"

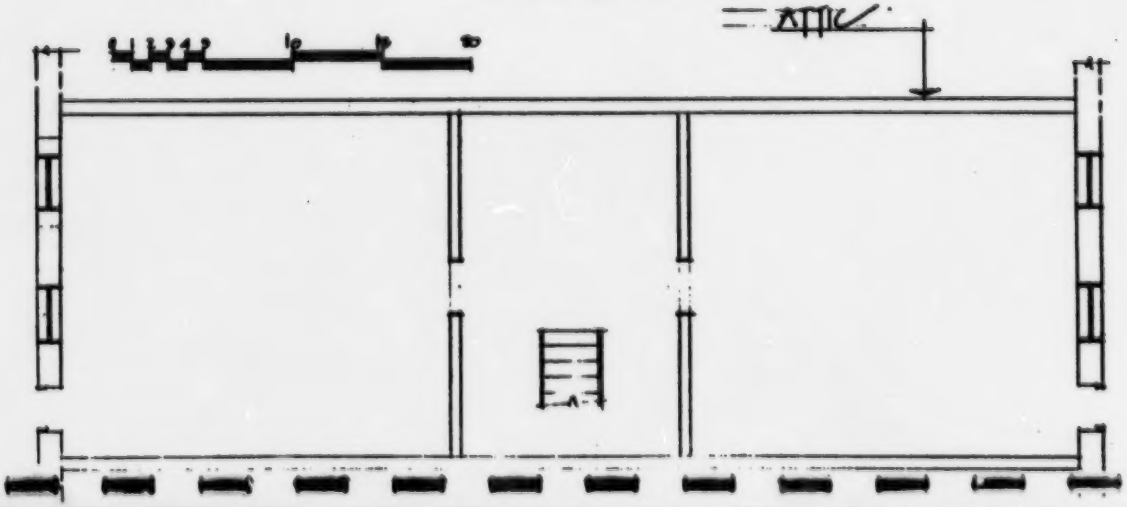


KUSELAND
RECREATIONAL CENTRE
KUSELAND, SASKATCHEWAN.

MAIN FLOOR PLAN

SCALE: 1/8" = 1'-0"





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RECREATIONAL CENTRE
LUSELAND, SASKATCHEWAN.

SECOND FLOOR PLAN.
& ATTIC.
SCALE 1/4"=1'-0"

1.4 Energy Usage

Energy consumption for the building for the past three years is tabulated on Table 1.1, and shown graphically on Figures 1.1, 1.2 and 1.3.

Natural gas consumption is enormous due to boiler inefficiency and the leaky wall/window construction.

Natural gas consumption fluctuates normally with the changing seasons. Electricity consumption fluctuates widely with no consistency from year to year. Initially this appears highly unusual. Upon closer examination of the quantities involved, it becomes evident that the high peaks could be caused by only a few days of extra electrical consumption. Relative to the normal low usage, the peaks appear exaggerated.

A normal commercial facility of this size, used full time, would likely have a basic electrical consumption above the peak consumption of this facility. Gas consumption would be far less.

For the purposes of this report, published 1982 energy prices will be used:

Electricity Consumption	- 5.6¢/kWh
Gas Consumption	- 11.21¢/m^3 (29.9¢/100 cu. ft.)
Water and Sewer	- $30.00/10,000 gal.

2. INVESTIGATION

2.1 General

The original architectural design drawings were obtained and examined. All details were very close to actual construction. See Figures 2.1, 2.2 and 2.3. Fire escape doors, landings and stairs have been added to the exterior of the building. No printed details were available of the two existing fan systems.

The building was examined on two separate occasions in March and April by Saskmont mechanical and electrical technicians and engineers.

The study included visual inspection of the building and system operation, and testing of system components. Photographs were taken to record visible problem areas.

2.2 Architectural

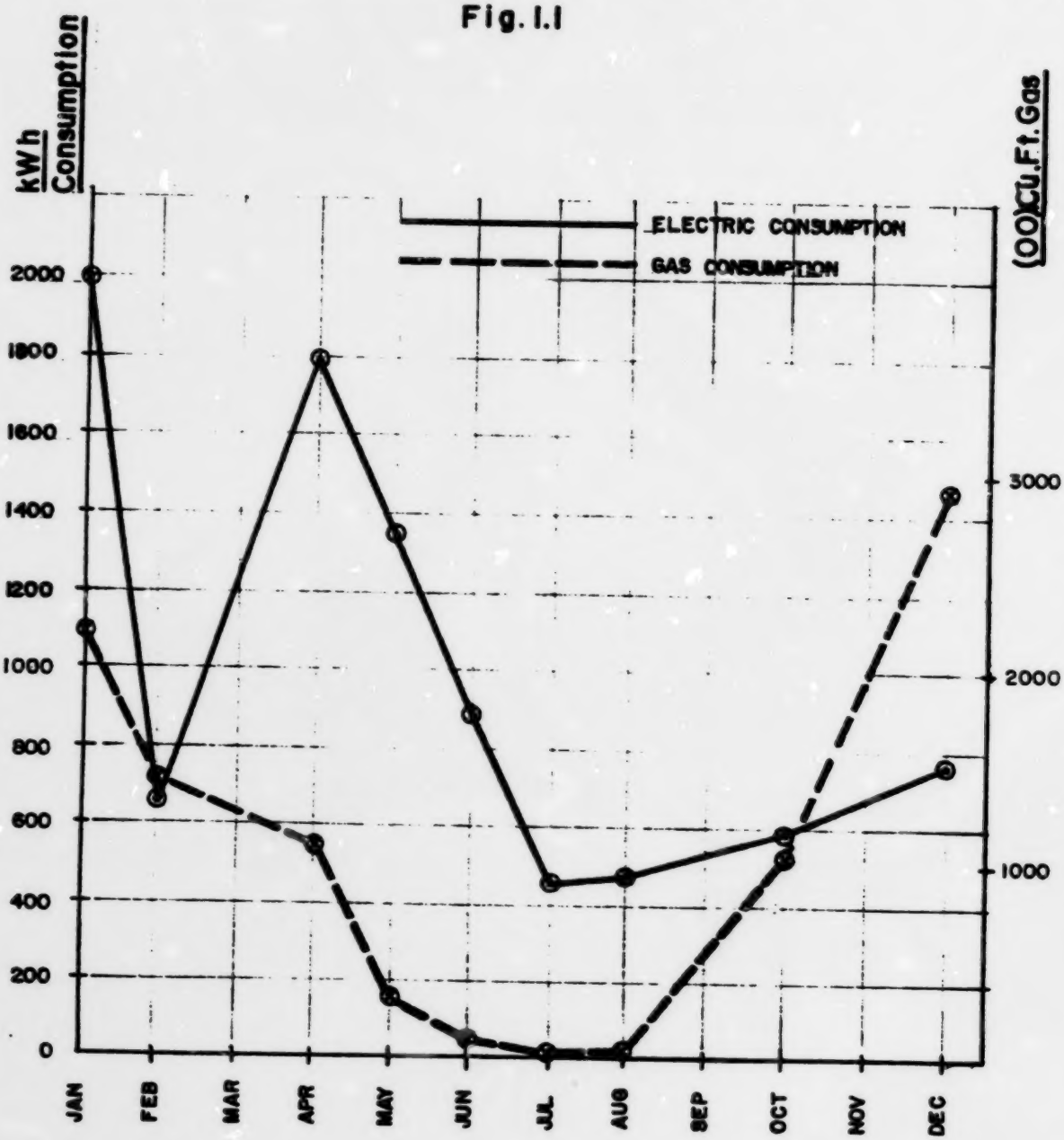
Wall construction is a composition of 4 in. face brick, 4 in. hollow tile, strapping, lathe and plaster. No insulation was evident in design drawings or visual inspection. The insulation value of the wall is calculated as R6.15.

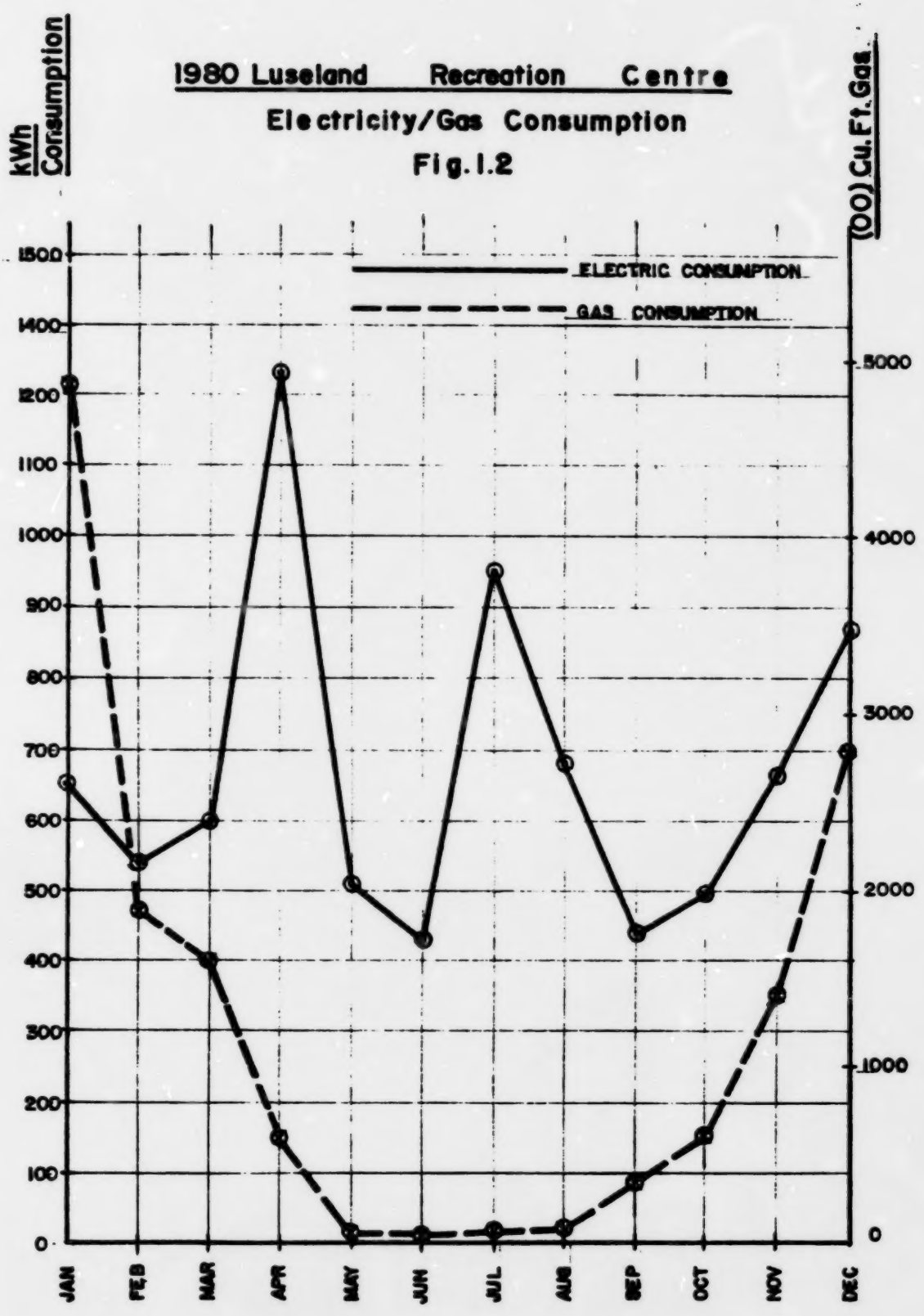
Five feet of the basement wall extends above ground. This wall is composed of 12 in. of concrete. The insulation value is calculated as R2.65.

1981 Luseland Recreation Centre

Electricity/Gas Consumption

Fig. 1.1




1980 Luseland Recreation Centre
Electricity/Gas Consumption
Fig. 1.2
kWh Consumption
(00) Cu. Ft. Gas
ELECTRIC CONSUMPTION
GAS CONSUMPTION
1500
1400
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
5000
4000
3000
2000
1000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

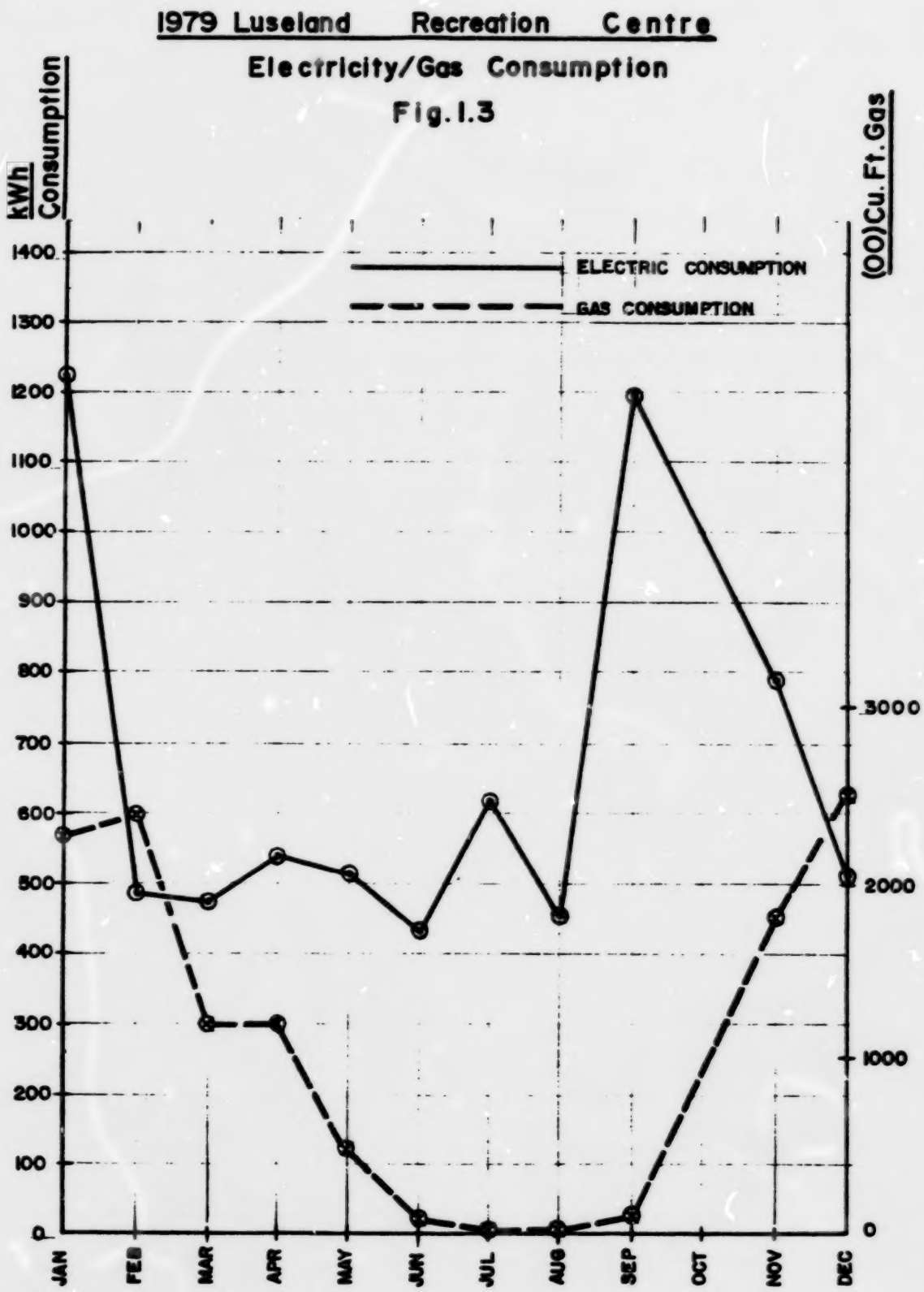

1979 Luseland Recreation Centre
Electricity/Gas Consumption
Fig. 1.3
kWh Consumption
(00)Cu. Ft. Gas
ELECTRIC CONSUMPTION
GAS CONSUMPTION
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
3000
2000
1000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Table 1.1 - Historic Energy Consumption

	1979		1980		1981	
	Electricity	Gas	Electricity	Gas	Electricity	Gas
January	1,220	2,366	650	4,866	2,050	2,219
February	490	2,411	530	1,864	669	1,397
March	470	1,162	594	1,663		
April	540	1,185	1,280	601	1,800	1,109
May	510	500	510	40	1,360	312
June	430	69	433	19	890	100
July	620	17	950	26	451	22
August	454	24	680	37	482	52
September	1,160	83	440	379		
October			490	612	593	1,028
November	790	1,824	658	1,441		
December	470		866	2,820	760	2,887
TOTALS	7,154	9,641	8,081	14,368	9,055	9,126

Electricity kWh - 3 year average 8,096 kWhr.
Gas (100's) cu. ft. - 3 year average 1,104,500 cu. ft.

Electricity	0.9	EKWH/SF/YR
Gas	36.8	EKWH/SF/YR
Total	37.7	EKWY/SF/YR*

* Equivalent kilowatt hours per square foot per year.

Table 1.2 - Historic Energy Costs

Electricity Costs

Date Effective	Cost Breakdown
February, 1979	Minimum first 50 kWh = $4.25 Next 400 kWh = 5.59¢/kWh Next 3550 kWh = 4.00¢/kWh Balance = 2.60¢/kWh
February, 1980	Minimum first 50 kWh = $4.50 Next 400 kWh = 5.5¢/kWh Next 3550 kWh = 4.4¢/kWh Balance = 3.1¢/kWh
February, 1981 to February, 1982	Minimum first 30 kW = $5.05 Next 400 kWh = 6.0¢/kWh Balance = 4.7¢/kWh

Natural Gas Costs

Date Effective	Cost Breakdown
December, 1978	First 85 cm = 10.7¢/cm Next 85 cm = 7.7¢/cm Next 4078 cm = 6.3¢/cm Balance = 5.9¢/cm
May, 1979	First 85 cm = 10.7¢/cm Next 85 cm = 7.6¢/cm Next 4078 cm = 6.3¢/cm Balance = 5.9¢/cm
December, 1979	First 85 cm = 10.9¢/cm Next 85 cm = 7.8¢/cm Next 4078 cm = 6.5¢/cm Balance = 6.1¢/cm
February, 1980	First 85 cm = 11.2¢/cm Next 85 cm = 7.5¢/cm Next 4078 cm = 6.7¢/cm Balance = 6.4¢/cm
November, 1980	First 80 cm/month = 13.69¢/cm Next 80 cm/month = 10.43¢/cm Next 3850 cm/month = 8.9¢/cm Balance = 8.56¢/cm
May, 1981	First 80 cm/month = 14.25¢/cm Next 80 cm/month = 10.99¢/cm Next 3850 cm/month = 9.46¢/cm Balance = 9.12¢/cm
July, 1981 to February, 1982	First 80 cm/month = 14.81¢/cm Next 80 cm/month = 11.55¢/cm Next 3850 cm/month = 10.02¢/cm Balance = 9.68¢/cm

2. INVESTIGATION (Cont'd)

2.2 Architectural (Cont'd)

The attic wall is wood frame with R8 fiberglass batting. The attic sloping wall and ceiling have no insulation. The second floor ceiling has 1.5 in. of loose fill fiberglass insulation. This area has an insulation value of R6.44.

At the time of the study, upstairs windows were in poor condition. Several window panes were missing, several windows were broken, one was open, and several of the double hung units had one pane up and three down, or vice versa. To reduce draft, some windows were covered with polyethylene. Basement windows were all covered from the exterior with 3/8 in. chipboard. The windows inside were in conditions ranging from "good" to "missing". Infiltration through many units was high despite the wooden cover. No weather-stripping was evident on any openable windows. Insulation value of the windows ranged from R-0 to R 1.7. Infiltration through leaky windows ranges from 30 to 65 C.F.H./lin. ft. of frame.

All exterior doors were poorly fitted. Proper weatherstripping was not evident in any doors. Infiltration is estimated at 450 CFH lin. ft. of frame.

Overall air leakage through doors and windows is estimated as comprising 47% of the building heat loss. Conducted heat loss through windows is estimated at 12%. Conducted heat loss through walls, basement, and roof amounts to 41% of total building heat loss.

2.3 Occupancy

The recreation centre is being used by a number of different groups at present. Half the first floor and basement are devoted to community recreation. The remaining half of the first floor has recently been vacated by a town jeweller/applicance serviceman. Half of the second floor has been devoted to the town policeman and court. The balance of the second floor and attic space is used weekly by Boy Scouts, Cub Scouts and an art class.

Community usage of the facilities is typically light. The community recreation section is normally occupied only by the recreation director in office hours. The school holiday season sees more children using the recreational facilities. The police department is typically occupied only intermittently. The other free area in the building is used for a variety of community group meetings an average of about twelve nights per month at three hours per evening.

Lighting was switched off in unoccupied areas at the time of the site investigation. Attitudes of both regular occupants, the police and recreation director, appear to be favourable towards energy conservation.

2. INVESTIGATION (Cont'd)

2.4 Mechanical Systems

A one-pipe steam system heats the structure. A converted coal-fired to gas-fired 560 MBH boiler provides steam to the system at a pressure of 1 to 2 psi. Seasonal efficiency of the boiler is probably less than 60%. A low voltage zone thermostat, located on the second floor, series connected to a steam pressure controller modulates boiler firing. The simple control system has proved durable, but climate control is not sensitive to individual spaces. Second and third floor occupants are generally cold in winter, while areas in the basement overheat.

Steam distribution piping is randomly insulated. Insulation has fallen off the boiler exterior. Many radiator shut-off valves handles are missing, resulting in reduced individual space control and increased discomfort. Heating problems were evident during the site investigation. With the boiler operating, upstairs radiators were cold, and some lower rads were only half hot.

An electric 22 gallon hot water heater is situated in the women's washroom. This provides hot water to the police office, recreation office and washrooms. Piping is uninsulated.

Urinals in the boy's washroom automatically flush every few minutes. Due to the frequent wetting, severe mineral deposits have formed on the porcelain.

The existing forced air ventilation systems appear to be abandoned. A simple duct system extends vertically to draw air from the finished attic space and discharge into the lower two floors through wall registers. A tee in the ducting downstream of the fan would split in equal amount of air to exhaust through the roof as would be supplied to the lower rooms. The fans are located in the unfinished space on the south side of the attic. One system would ventilate rooms on one side of the stairwell. The east side fan is seized. The west side fan is operative. Toggle switches on the finished attic wall control the fans. Wall grilles in the lower two floors are blocked with plywood.

2.5 Electrical Systems

The electrical service to the building is a 100 amp, 120/240 single phase overhead system with the breaker type panelboard located under the basement stairs.

The distribution wiring is a mixture of conduit and wire, and armoured cable (Bx). Bx being used for any changes made.

As the system now exists it is adequate for the present usage of the building. If any number of high usage equipment is installed, such as electric kilns, or ranges, the service would have to be increased in size.

2. INVESTIGATION (Cont'd)

2.5 Electrical Systems (Cont'd)

The fire alarm system is a 24VAC non-supervised non-zoned system. There is no emergency or exit lighting.

2.6 Energy Conservation Opportunities

.1 General

Potential energy conservation measures are labelled either "ECO", "Quick Fix", "Operational" or "Maintenance".

"ECO" - energy conservation opportunity normally requiring further investigation, design, and costing prior to implementation.

"Quick Fix" - items that may normally be implemented immediately requiring small capital expense and little further justification.

"Operational" - changes to operational procedures or setpoint.

"Maintenance" - areas where maintenance can be improved.

The description of work involved for each opportunity is at a "pre-conceptual" level. It is only intended to state the idea of the work not the actual details required. For the ECO's, several design options for each work may be available.

Capital costs are presented for each item along with an estimate Class:

Class I - ±10%
Class II - ±20%
Class III - ±30%
Class IV - less accurate than above.

Class I estimates are normally only available after complete design of a project.

Class II estimates are normally only available after total project scope is established.

Class III estimates are achievable in most cases at this stage, however in some cases due to a multitude of options available, Class IV estimates are used.

Energy savings are calculated in a formatted manner using the calculations given in Appendix "A". They are also given an estimate class:

Class I - ±10% estimate
Class II - ±25% estimate
Class III - ±50% estimate
Class IV - less accurate than above.

2. INVESTIGATION (Cont'd)

2.5 Energy Conservation Opportunities (Cont'd)

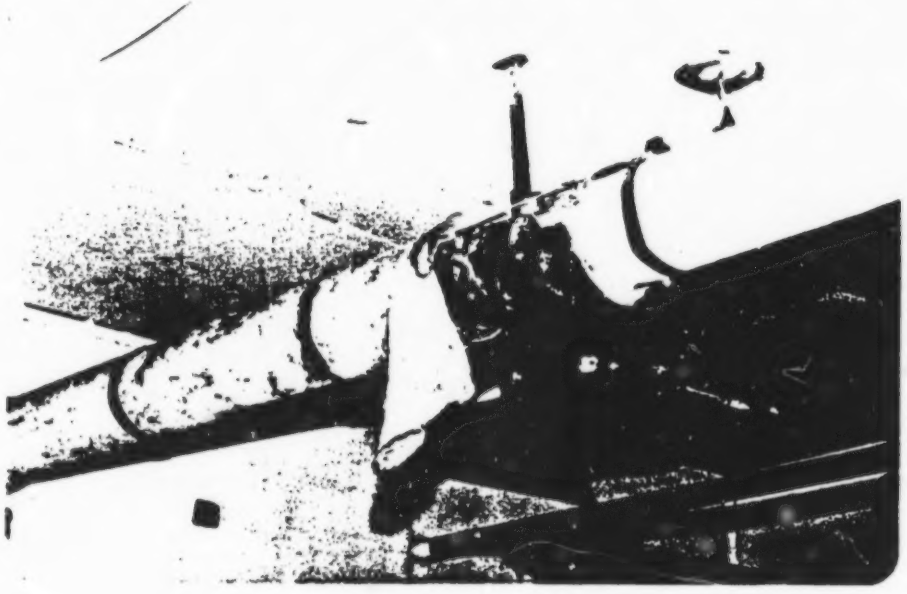
.2 Summary of Energy Conservation Measures

Option	Description	Category	Payback * (years)
1.	Basement temperature	Operational	immed.
2.	Automatic flush urinals	Quick Fix	0.3
3.	Weatherstrip front door	Maintenance	0.7
4.	Repair and seal windows	Maintenance	2.3
5.	Radiator valve handles	Maintenance	N/A
6.	Insulate basement windows	Quick Fix	2.5
7.	Seal roof exhaust	Quick Fix	3.0
8.	Increase attic insulation	Quick Fix	5.8
9.	Install sealed D.G. windows - relative to option 4 done first	E.C.O.	10.2 24.1
10.	Insulate steam pipes	Quick Fix	4.3
11.	Replace boiler insulation	Maintenance	10.0
12.	Meeting room lighting	E.C.O.	22.7
13.	Boiler pressure gauge	Maintenance	N/A
14.	Retrofit wall insulation	E.C.O.	41.0
15.	Install automatic valves	E.C.O.	4.1
16.	Interior window shades	Maintenance	N/A
17.	Natural shading	E.C.O.	----
18.	Insulate basement wall	E.C.O.	32.1
19.	Insulate upper section of windows - relative to option 4 done first	E.C.O.	7.1 16.6

* Payback relative to original building's condition except as noted.

1. Basement Temperature

1.	Situation	.1	Due to heat gain from the boiler and main steam pipes as well as radiators, the basement overheats.
2.	Solution	.1	Close down or shut-off radiator valves in the basement. This will reduce temperature and excess heat loss accordingly.
		.2	Estimated Cost: N/C.
3.	Saving	.1	Reducing the temperature to 50°F will cut basement heat loss by about 20% = $60 Class II.
4.	Remarks	.1	Operational Item.
		.2	Unit heaters in the basement can warm the space rapidly immediately prior to being used.



TYPICAL BASEMENT RADIATOR

2. Automatic Flush Urinals

1. Situation

.1 The basement urinals flush automatically every few minutes, wasting a great deal of water in light of the low usage. The constant wetting has severely stained the fixtures.

2. Solution

.1 Install a manual flush valve at each of 3 urinals. If increased use in the future is expected, a solenoid control valve on the waterline tied to washroom lights may be a more desirable option.

.2 Estimated Total Cost: $300.00 Class III.

.3 Saving

.1 Water consumption:

= (3 gal/flush) (12/hr.) (24) (365) (90% reduction)
= 315,360 Gal./annum
= $946 Class II Estimate.

4. Remarks

.1 Quick Fix.

.2 The aesthetics of the washroom will be greatly improved if this measure is implemented in conjunction with new urinals.

3. Weatherstrip Front Door

1. Situation
   - .1 The front door is poorly fitted and only partially weatherstripped.
2. Solution
   - .1 Remove existing weatherstripping and replace with good quality magnetic/vinyl material. If this is inadequate to seal the cracks, the door should be reset.
   - .2 Estimated Cost: $100.00 Class II.
3. Saving
   - .1 Reduced Infiltration:

     Present infiltration = 450 CFH/foot of crack
     Proposed infiltration = 150 CFH/foot of crack
     Crack length = 26 feet
     (26 ft (450-150CFH)/60)(1.1)(10970)(24)(.7)/100/.60
     = 43920 cu. ft. gas
     = Class II. Calculation C-3
     = $130
4. Remarks
   - .1 Maintenance Item.
   - .2 A proper door closer is required.

4. Repair and Seal Windows

1. Situation

.1 Several upstairs exterior double hung windows are: missing, broken, in the one pane up/ three panes down, or in the partially open position.

2. Solution

.1 One solution is to repair all broken windows, seal all but one unit in each room and weather-stip the remaining openable unit. This will greatly reduce infiltration yet retain some natural ventilation.

.2 Estimated Cost: $1,500.00 Class III.

3. Saving

.1 Infiltration as well as conducted heat loss through open and broken windows.

.2 Infiltration heat loss:

Present infiltration = 30 to 65 CFH/ft.
assume 50 CFH/ft average
Proposed infiltration = 15 CFH/ft.
Crack length = 938 ft.
(938 ft. (50 CFH - 15 CFH)/60)(10970)(1.1)
(24)(.7)/1000/.60
= 184870 cu. ft. gas, Calculation C3

.3 Conducted heat loss through broken and open windows:

Window area = 200 SF

= (1.11-0.59)(200 SF)(10970)(24)(0.7)/1000/.60
= 31,940 cu. ft. gas. Calculation C-4.

.4 Total

= 216,810 cu. ft. gas
= $650 Class II.

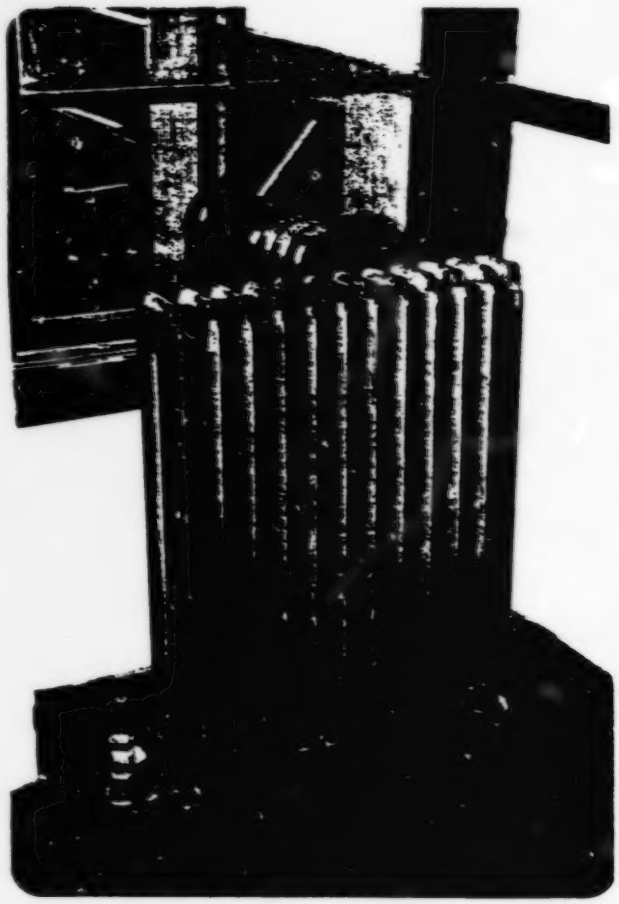
4. Remarks

.1 Maintenance Item.

.2 See Item #9 and #19 for alternates to above.

5. Radiator Valve Handles

1.	Situation	.1	Only few steam radiator shut-off handles are in place, preventing manual heating control in the majority of rooms.
2.	Solution	.1	Install new valve handles on all radiators.
		.2	Estimated Cost: $220.00 Class II.
3.	Saving	.1	Heat lost to outdoors when windows open to alleviate overheating.
4.	Remarks	.1	Maintenance Item.



6. Insulate Basement Windows

1. Situation

.1 Basement windows are presently boarded. The condition of the windows behind ranges from missing to good. Excess infiltration and conducted heat losses result from this arrangement.

2. Solution

.1 Install R-12 insulation and vapour barrier behind the board and seal and finish the interior.

.2 Estimated Cost: 21 windows @ $30 = $630
Class III.

3. Saving

.1 Reduced conduction heat loss:

Present R-value = 2.4, U value = 0.42
Proposed R-value = 14.4, U value = 0.07
Area of windows 135 SF

= (0.42 - 0.07)(135 SF)(10970)(24)(.70)/1000/.60
= 14,510 cu. ft. gas. Calculation C-4.

.2 Reduced infiltration heat loss:

Present infiltration = 65 CFH/Fft. of crack
Proposed infiltration = neglibible
Crack length = 193 ft.

= [(193 ft)(65 CFH/60 MIN)(1.1)(10970(24)(.7)/
1000/.60
= 70,640 cu. ft. gas. Calculation C-3.

3. Total

= 85,150 cu. ft. gas
= $250 Class II

4. Remarks

.1 Quick Fix Item.

.2 This measure can be partially justified for aesthetic improvements of the interior.

TYPICAL BASEMENT WINDOWS - INSIDE VIEWS

7. Seal-Off Roof Exhaust

1. Situation

.1 The unused fan system forms a passage for warm building air to draught up the ducting and out the roof exhaust.

2. Solution

.1 Sealing closed the ducting above the fan unit will greatly slow exfiltration in this manner.

.2 Estimated Cost: $300.00 Class III.

3. Saving

.1 Reduced exfiltration:

Estimated infiltration due to fan systems 100 CFM

= (100 cfm)(1.1)(10970)(24)(.7)/1000/.60
= 33,790 cu. ft. gas. Calculation C-3.
= $100 Class III

4. Remarks

.1 Quick Fix Item.

8. Increase Attic Insulation

1. Situation

.1 Some areas of the attic have little or no insulation, resulting in unnecessarily high heat loss.

2. Solution

.1 Insulate sloping attic wall vertically and access doors with 3½ in. (R-12) fiberglass batt, and horizontal areas of attic with 5½ in. (R-20) fiberglass batt laid across the ceiling joists. Poly vapour barrier should be inserted on the warm side of the insulation.

.2 Install natural draft soffit vents to prevent condensation problems.

.3 Estimated Cost: $1,800.00 Class III.

3. Saving

.1 Conducted heat loss:

Note: Use CD of 0.4 for attic area.

a) Access Doors

Present R-value = 12, U1 = 0.5
Proposed R-value = 15, U2 = 0.067
2 access doors at 12 SF each

= (.5-.067)(24 SF)(10970)(24)(.4)/1000/.60
= 1820 cu. ft. gas. Calculation C-4.

b) Vertical Area

Present R-value = 8, U1 = 0.125
Proposed R-value = 20, U2 = 0.05
Area = 840 SF

= (.125-.05)(840 SF)(10970)(24)(.4)/1000/.60
= 11,060 cu. ft. gas. Calculation C-4.

c) Sloping Area

Present R-value = 2, U1 = 0.5
Proposed R-value = 14, U2 = 0.071
Area = 721 SF

= (0.5-0.071)(721 SF)(10970)(24)(.4)/1000/.60
= 54,290 cu. ft. gas. Calculation C-4.

8. Increase Attic Insulation (Cont'd)

3. Saving

.1 (Cont'd)

d) Horizontal Area

Present R-value = 6.4, U1 = 0.156
Proposed R-value = 26.4, U2 = 0.038
Area = 1683 SF

= (0.156-0.038)(1683 SF)(10970)(24)(.4)/
1000/.60
= 34,860 cu. ft. gas. Calculation C-4.

e) Total

= 102,030 cu. ft. gas
= $310.00 Class II.

4. Remarks

.1 Quick Fix Item.

.2 It is important to improve the attic ventilation level to modern recommended standard after reinsulation to prevent condensation problems. Item 2.2 above.

9. Install Sealed Double Glazed Windows

1. Situation

.1 Existing windows are loose fitting, resulting in high infiltration as well as high conducted heat loss through the glass.

2. Solution

.1 Install new sealed double glazed window units inside the existing windows. Repair the existing windows for aesthetic appearance.

.2 Estimated Cost: $10,400 over present stats.
$8,900 over option 4.

3. Saving

.1 Reduced infiltration and conducted heat loss.

.2 Infiltration:

Present infiltration with windows repaired = 15 CFH/ft. (see option 4)
Proposed infiltration = 7 CFH/ft.
Crack length = 938 ft.

= [(938 ft.)(15 CFH-7 CFH)/60 min](1.1)(10970)(24)(.7)/1000/.60
= 42,260 cu. ft. gas. Calculation C-3.

.3 Conducted:

Present R-value with windows repaired = 1.7, U1 = 0.59 (see option 4)
Proposed R-value = 3.4, U2 = 0.29
Area = 878 SF

= (0.59-0.29)(878 SF)(10970)(24)(.7)/1000/.60
= 80,910 cu. ft. gas. Calculation C-4.

.4 Total:

= 123,170 cu. ft. gas
= $370 Class III (improvement over option 4)

4. Remarks

.1 Quick Fix Item.

.2 See Item #4 and #19 as alternates to above. ✓

.3 Total savings are 339,980 cu. ft. of gas and $1,020 over presentat state of building.

.4 The simple payback increased from 10 years to 24 years if the existing windows were put into good shape.

10. Insulate Steam Pipes

1. Situation

.1 Radiator steam supply and condensate return piping is uninsulated. Main piping is insulated. Heat loss through uninsulated piping on lower floors contributes to overheating on lower floors, and underheating on upper floors.

2. Solution

.1 Insulate all steam supply/condensate return piping with rigid 1 in. fiberglass pipe insulation complete with All Service Jacket.

.2 Estimated Cost: 300 feet of pipe at $3.30/ft.
$940 Class III

3. Saving

.1 Reduced discomfort due to overheating and underheating.

.2 Reduced basement heat loss due to lower temperature.

.3 Heat loss from steam pipes:

= Pipe temperature = 200°F
= Pipe size = 2" average
= Heat loss uninsulated = 123 Btuh/ft.
= Heat loss insulated = 23 Btuh/ft.

Therefore annual heat loss from pipes assuming the boiler operates for 8 months of the year is:

= Uninsulated = 300 ft. x 123 Btuh/ft. x 8 mo. x 30 day x 24 h.
= 212,544,000 Btu's
= Insulated = 300 ft. x 23 Btuh/ft. x 8 mo. x 30 day x 24 h.
= 39,744,000 Btu's
= Difference = 172,800,000 Btu's

Pipe is not always at 200°F and some of the heat loss provides heating to the building. Therefore assume only 25% of this heat is wasted.

= Waste heat = 43,200,000 Btu's

Convert to natural gas (1000 Btu's = 1 CF gas) and divide by boiler efficiency (60%) yielding:

= Gas wasted = 72,000 CF/year
= Savings $220/year Class III estimate.

4. Remarks

.1 Quick Fix Item.

11. Replace Boiler Insulation

1. Situation

.1 Existing insulation has cracked and partially fallen away from the boiler. A significant portion of the heat lost to the room is conducted outside through the boiler room and coal storage room exterior walls.

2. Solution

.1 Remove existing insulation and replace with new material.

.2 Estimated Cost: 160 SF at $10/SF
$1,600 Class III

3. Saving

.1 Reduced conducted heat loss through exterior walls and reduced heat gain to basement rooms.

.2 Heat loss from boiler:

Boiler temperature = 200°F
Surface area = 160 SF
Present R-value of insulation = average R of 2 and U1 = 0.5
Proposed R-value of insulation to be about R of 10, U2 = 0.10

Therefore heat wasted from boiler would be:

(U1-U2)(AREA)(TEMP DIFF)(HRS OF OPERATION)

= (.5-.1)(150 SF)(200°-70°)(8 mo.x30 daysx24 h.)
= 44,928,000 Btu's

As boiler is usually at a high temperature and while some of the warm heat is useful for heating, most of it will be wasted. Assume 70% wasted heat.

= Waste heat = 31,449,600 Btu's.

Converting to natural gas (1000 Btu's = 1 CF gas) and divide by boiler efficiency (60%) yielding:

= Gas wasted = 52,420 CF/year
= Saving = $160/year. Class III estimate.

4. Remarks

.1 Maintenance Item.

12. Meeting Room Lighting

1. Situation

.1 Lighting is now provided by inefficient 300W incandescent suspended fixture.

2. Solution

.1 Remove existing incandescent suspended fixture, and install 90 W (2/40 wall lamps) fluorescent type fixtures.

.2 Approximately same light level achieved, but no glare and greater diffusion of light.

.3 Estimated Cost per room: $115.00 x 8 = $920.00. Total cost 4 rooms = $3,680.00 Class IV.

3. Savings:

.1 Electrical consumption, assuming operation of 12 days/month up to 3 hours per day:

= no. rooms x no. fixtures x (incandescent watt - fluorescent watt) x hrs/day x day/month x month/year / 1000

= 4 x 8 x (300W - 100W) x 3 x 12 x 12/1000
= 2900 kWh/year
= $162

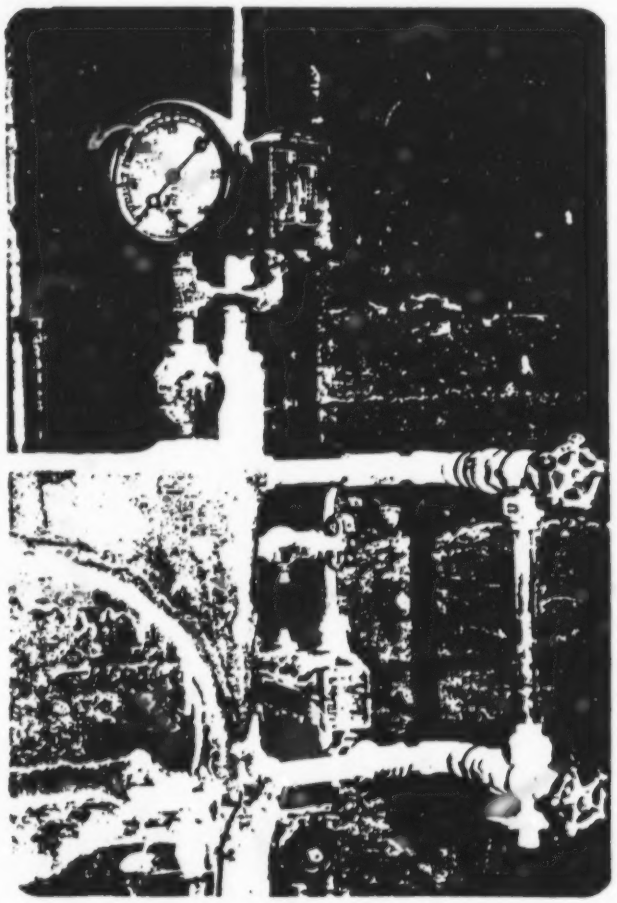
4. Remarks

.1 Energy Conservation Opportunity.

.2 If usage is increased to 8 hours per day, 5 days per week, payback period would be reduced from 23.8 years to 5.1 years.

13. Boiler Pressure Gauge

1.	Situation	.1	Pressure gauge on boiler steam supply pipe is inoperative.
2.	Solution	.1	Replace same.
		.2	Estimated Cost: $50 Class III
3.	Remarks	.1	Maintenance Item.
		.2	Pressure control switch may also require maintenance.



14. Retrofit Wall Insulation

1. Situation

.1 The existing brick wall composition yields an insulation value of R-6.15. Wall heat loss comprises about 18% of total building heat loss.

2. Solution

.1 Install strapping, R-12 fiberglass batt insulation, vapour barrier and cladding on the inside of exterior walls.

.2 Estimated Cost: $20,000 Class IV

3. Saving

.1 Conducted heat loss:

Present R-value = 6.15, U1 = 0.163
Proposed R-value = 18.15, U2 = 0.055
Wall area = 4920 SF

= (0.163-0.055)(4920 SF)(10970)(24)(.7)/1000/.60
= 163,210 cu. ft. gas. Calculation C-4.
= $488/year. Class II.

4. Remarks

.1 ECO Item.

.2 Actual cost depends on treatment of windows and finishes chosen.

15. Install Automatic Valves

1.	Situation	.1	Manual steam control valves now situated in each room require user adjustment for comfort control. Slow heat response time usually produces discomfort. Refuge from the heat is sometimes sought by opening windows.
2.	Solution	.1	Install electric thermostatically controlled solenoid valves on the steam supply pipe.
		.2	Estimated Cost: 9 zones @ $300.00 = $2,700.00 Class III.
3.	Saving	.1	Increased comfort and reduced heat loss through opened windows.
4.	Remarks	.1	Probably 20% of present heating cost is due to overheating. Installation of control will reduce heat by 220,900 C.F. or $660/yr. Class IV estimate.
		.2	ECO Item.

16. Interior Window Shades

1. Situation

.1 The south and west faces of the building are exposed to the full heat of the sun, causing overheating and discomfort.

2. Solution

.1 Repair or replace interior roll shades to provide required solar shading on problem windows (south and west orientations).

.2 Estimated Cost: $1,500.00 Class III.

3. Remarks

.1 Maintenance Item.

.2 No dollar saving will result from this measure unless problem rooms will be electrically air conditioned. In this case reduced heat gain would offset air conditioning costs.

.3 The existing shades are badly deteriorated.

17. Natural Shading

1. Situation

.1 The south and west faces of the building are exposed to the full heat of the sun, causing occasional overheating.

2. Solution

.1 Plant grown deciduous trees adjacent to the south and west faces of the building.

.2 Estimated Cost: $10,000.00 Class II.

3. Remarks

.1 No dollar saving will result from this measure unless problem rooms will be electrically air conditioned. In this case, reduced heat gain from walls and windows would offset air conditioning costs.

.2 Trees may be justifiable on an aesthetic basis, as well as more complete wall shading than window shades.

18. Insulating Basement Walls

1. Situation

.1 Concrete basement walls are not insulated causing a high heat loss.

2. Solution

.1 Frame and insulate walls with a R-12 fiberglass batt insulation. Install a vapour barrier and finish wall with a wall board.

.2 Estimated Cost: $10,000 Class III.

3. Saving

.1 Reduced heat loss through basement wall above ground level:

Present R-value = 2.65, U1 = 0.37
Proposed R-value = 14.65, U2 = 0.07
Area = 930 SF

= (.37-.07)(930 SF)(10970)(24)(.7)/1000/.60
= 85,700 cu. ft. gas. Calculation C-4.

.2 Reduced energy consumption through basement wall below grade:

Present edge value of wall U1' = 1.002
Proposed edge value of wall U2' = 0.271
Perimeter of wall = 186 ft.
Temperature in basement = 65°F
Ground temperature = 22°F

$$= \frac{(1.002-0.271)(186\text{ ft.})(65-22)(10970)(24)(0.70)}{[65-(-30)](1000)(.60)} \times 0.70$$

= 18,900 cu. ft. gas. Calculation C-5.

.3 Total Energy Saving Annually:

= 104,600 cu. ft. gas
= $312/year. Class II.

4. Remarks

.1 ECO Item.

19. Insulate Upper Section of Windows

1. Situation

.1 Large single pane windows with storm windows are generally in very poor condition constituting high heat loss.

.2 Most of the activity occurs in the evening when natural light has little or no effect.

2. Solution

.1 From the inside, insulate to R-12 and cover the top portions of all windows. This leaves the outside "Heritage Look" of the building.

.2 Estimated Cost $150.00/window

Total Cost:

= $150 x 36 windows
= $5,400 Class IV Estimate.

3. Saving

.1 Infiltration:

Present infiltration with windows repaired = 15 CFH/ft. (see option 4)
Proposed infiltration = negligible
Crack length = 938 ft./2 = 469 ft.

= [(469 ft.)(15 CFH-0)/60 min](1.1)(10970)(24)(.7)/1000/.60
= 39,620 cu. ft. nat. gas. Calculation C-3.

.2 Conduction:

Present R-value with windows repaired = R = 1.7, U1 = 0.59 (see option 4)
Proposed R-value = 13.7, U2 = 0.073
Area = 878 SF/2 = 439 SF

= (0.59-0.073)(439)(10970)(24)(.7)/1000/.60
= 69,710 cu. ft. gas. Calculation C-4.

.3 Total Saving:

= 108,970 cu. ft. gas
= $325/year. Class II, improvement to option 4.

4. Remarks

.1 ECO Item.

.2 See options 4 and 9 for alternatives to above.

.3 If option 4 and 19 are done together total cost is $6,900. Total savings are $975/year. Simple payback is 7.1 years.

19. Insulate Upper Section of Windows (Cont'd)

4. Remarks (Cont'd)

.4 Option 19's payback is 16.6 years over option 4.

.5 If option 9 and 19 are done together the total cost would be $10,000. Total savings would be $510/year over option 4. Simple payback is 19.6 years.